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H. Dupouy

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The Harvesting of the scallop Pecten maximus L. in France

Part I: Introduction to the fishery

by Hervé Dupouy

France is the world's fourth-largest producer of scallops, after Japan (Pactinopecten yessoensis), Canada and the United States (Placopecten magellanicus). It accounts for a tenth of world production.

The French fishery brings in over 20 000 tonnes of scallops per year. This is approximately two thirds of total European landings; the fisheries of Great Britain, Ireland, Italy and Spain together account for the remainder.

France's long-disregarded scallop fishery is scoring spectacular gains: production has more than tripled in the course of the past decade.

Species	Value (10^6 francs)	Weight (10^3 tonnes)
Cod (Gadus morhua, Linnaeus)	146	38
Hake (Merluccius merluccius, Linnaeus)	145	21
Green pollack (Pollachius virens, Linnaeus)	113	70
Yellowfin tuna (Thunnus albacares, Bonnaterre)	93	28
Norway lobster (Nephrops norvegicus, Linnaeus)	91	11
Scallop (Pecten maximus, Linnaeus)	66	23

Table 1. In the French fishing industry, scallops are the sixth-ranking species in terms of total quantities landed.
Source: Marine fisheries statistics, 1973.

At present over 10% of all French fishermen engage in scallop harvesting on a regular basis and derive a substantial share of their income from that activity. In 1973 the total value of the catch, in terms of the prices paid to producers, exceeded 66 million francs, making scallops the sixth-ranking species among all products of the French fishing industry (see Table 1).

1. Biology

The genus Pecten inhabits temperate seas exclusively. Of the two species harvested in Europe, P. maximus is the more widely distributed, occurring from Norway to Spain. The other is the Mediterranean species P. jacobeus, which is concentrated mainly along the coastline of Italy.

Scallops are found from the lowest low water line out to depths of 120 m, but are most abundant in water depths of between 10 and 40 m.

Scallops prefer unfixed substrates, and consequently areas where the bottom consists of empty shells, deposits of maerl or muddy sand constitute ideal habitats for them. The scallop lies half buried, with only the edges of its parted valves emerging from the sediment.

It obtains its food by filtering sea water, intercepting phytoplankton and suspended particles of organic matter with its gills.

As a rule, sexual maturity occurs during the second year of life. As all scallops are hermaphroditic, the crescent-shaped gonad comprises an orange female part and a cream-coloured male part.

Reproduction takes place in spring or summer, depending on the region. The gametes are emitted directly into the environment. The spermatoza are emitted shortly before the ovula, and this means that the probability of self-fertilization is minimal. The fertilized egg, 60 microns in diameter, develops into a free-swimming larva that inhabits the surface layer, carried about by currents.

Two to three weeks later the larva settles to the bottom, and there it undergoes major transformations. In the course of this phase, which may last for two months, it moves about on a threadlike foot at times, while at other times it attaches itself by means of a byssus to a substrate. The juvenile scallop, which has been transparent up to this point, progressively assumes the colouring and morphology of the adult. At this stage it is about 1 centimetre in size (Le Pennec, 1975).

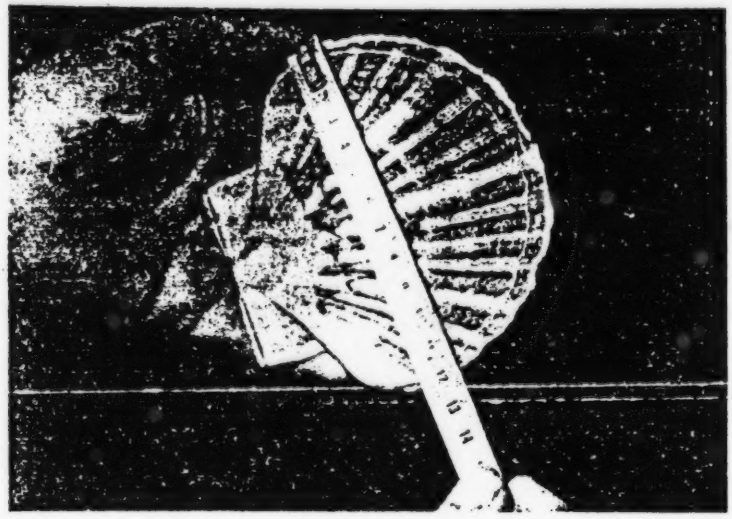

Fig. 1. This three-year-old scallop is larger than the minimum commercial size (10 cm) and weighs nearly 150 g.

Growth now proceeds more quickly, but subsequently comes to a halt as winter approaches. It will resume the following spring, at which time both valves will bear a concentric ring.

As a scallop ages, the yearly resumption of growth begins progressively later in the season, with the result that it is sometimes difficult to determine an individual's age from its growth rings.

In the absence of harvesting activity, it is not unusual to find specimens that are more than ten years old. Such a specimen may be as much as 17 cm in length and weigh over 500 grams.

Scallops of the same age may be of different weights and sizes in different regions. The water depth over the scallop bed is also a factor affecting weight and size.

None the less, it is broadly correct to say that most scallops reach commercial size, i.e. 10 cm at the point of maximum shell width, in two to three years. At this time an average specimen weighs approximately 100 grams (see Fig. 1).

Scallops can move in a spasmodic fashion by suddenly expelling the sea water within the pallial cavity. Even with jet propulsion, however, they do not travel far: the author has recaptured many marked scallops at the very place where he had immersed them two years previously. Another indication is to be found in the types of epibionts observable on scallop shells: sessile fauna and flora find these ideal places to settle in unstable terrain. The author has been able to determine that in Saint-Brieuc Bay there is a characteristic incidence of Crepidula fornicata parasitism on the scallops of each harvesting area.

2. The main beds

The fact that scallops lead sedentary lives doubtless explains why they occur as discrete populations which are differentiated by morphological and physiological characteristics.

The geographical expression of this situation is that scallop beds are found in clearly defined areas along coastlines. France's littoral possesses an abundance of them, from the Straits of Dover to Arcachon (see Figs. 2 and 3). The total area of these beds may be estimated at 5000 square kilometres. Given the fact that scallop production is over 20 000 tonnes yearly, it appears that mean productivity is 40 kg per square kilometre.

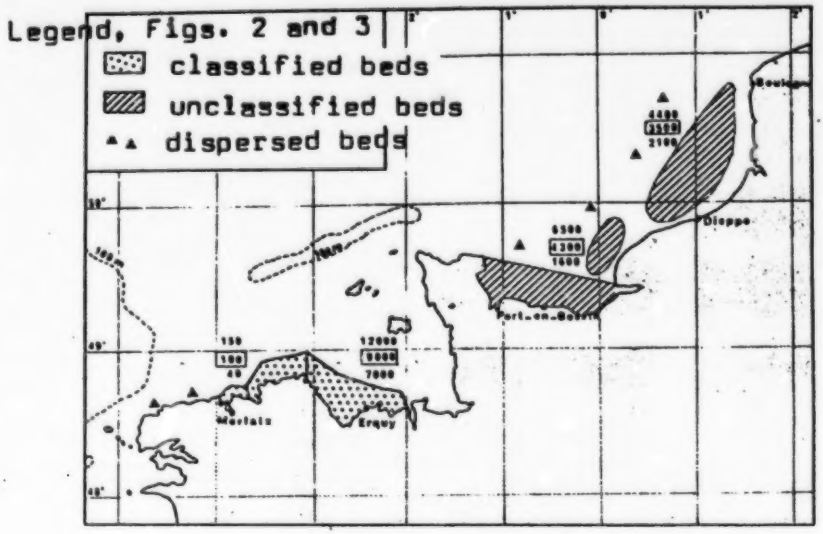

Fig. 2. The scallop beds of the English Channel. These are the most productive beds. The three values printed beside the position of each bed indicate, top to bottom, the maximum, mean and minimum production tonnage obtained over five harvesting seasons, from 1970-1971 to 1974-1975.

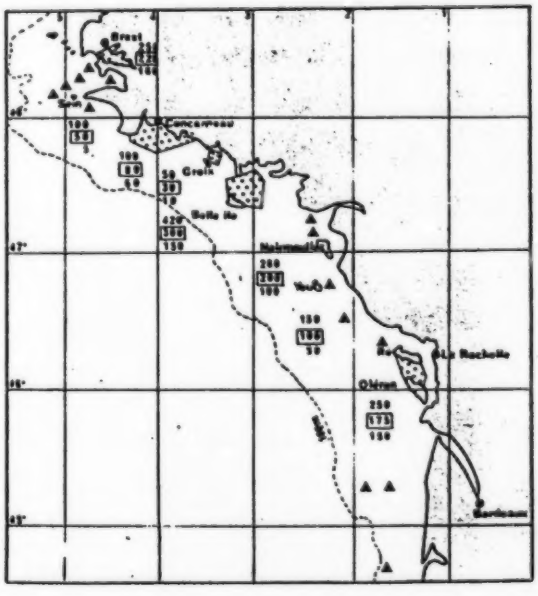

Fig. 3. The scallop beds of the Atlantic coast. The three values printed beside the position of each bed indicate, top to bottom, the maximum, mean and minimum production tonnage obtained over five harvesting seasons, from 1970-1971 to 1974-1975.

In point of fact, this figure is largely an abstraction in view of the uneven distribution of scallops on the bottom. The areas where harvesting is actually done are characterized by minimum yields fifty to one hundred times as high as this, and the most productive areas in Saint-Brieuc Bay, where the richest of all France's scallop beds are located, yield close to 500 kg per hectare.

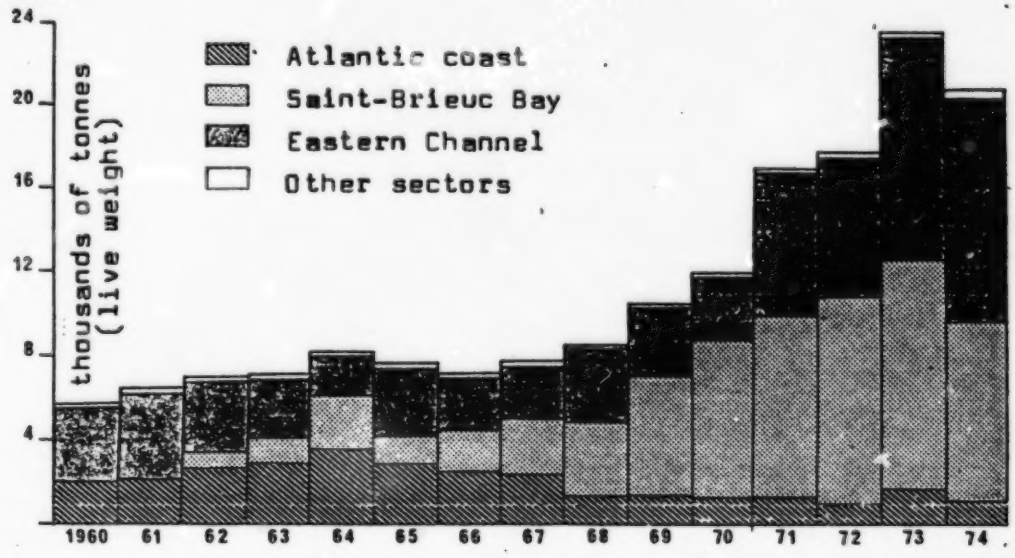

Fig. 4. Changes in production, by sector, between 1960 and 1974.
Source: Marine Affairs.

Sizable fluctuations also occur over time, as will be seen from Fig. 4, which shows catches in various regions during the period 1960 to 1974. The graph clearly shows the spectular gains in production that were obtained from the Channel and Saint-Brieuc Bay beds and the decline of the Atlantic sector in the course of those years. At present France's Channel coast produces nearly 20 000 of scallops each year, compared to less than 4000 tonnes in 1960.

There are many landing points, but four ports in particular, namely Erquy, Dieppe, Port-en-Bessin and Grandcamp, have virtually made scallops their speciality. These four ports account for over half the total tonnage landed.

3. Harvesting gear and boats

(a) Drags

Although scallops have been harvested with trawls on rare occasions, in general it is true to say that drags are the only type of specialized gear used in the scallop fishery.

The operating principle of a scallop drag is quite simple: a big rake at the front digs the scallops out of the sediment and deposits them in a trailing bag (see Fig. 5).

The belly of the bag is made of metal rings with an inside diameter of 7 cm, while the back is usually cut from trawl netting (mesh size 35 mm on a side).

One end of the bag is held open by a rectangular framework of metal strips. A forward-pointing metal triangle projects ahead of this; the tip of the triangle is attached to the towing warp by means of a shackle. The base of the rectangular metal framework is fitted with a row of regularly spaced teeth (one tooth every 10 cm).

There is a wooden or metal bar across the trailing end of the bag which gives the drag greater rigidity and facilitates manoeuvres.

This type of gear was first used by Dieppe scallop boats about 1930, and ever since has been known as the Dieppe drag. The original design has been somewhat modified and improved in the intervening years.

The teeth of a contemporary Dieppe drag, for example, are welded to an adjustable bar, so that any damaged teeth can be quickly replaced and the teeth can be set longer or shorter to work different types of ground.

As increasingly powerful engines have come into use and manual capstans have been replaced by winches, modern drags have come to be more heavily built

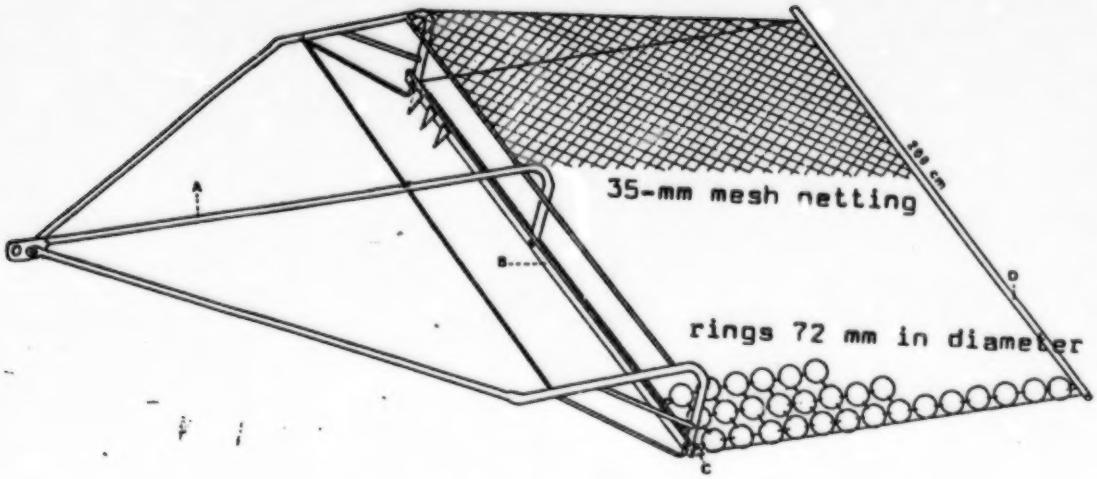

Fig. 5. The Dieppe drag, which is used in the eastern Channel sector. Its weight is restricted to 80 kg. A: triangular towing hitch. B: removable bar with teeth. C: angle bracket to which the bag is attached.

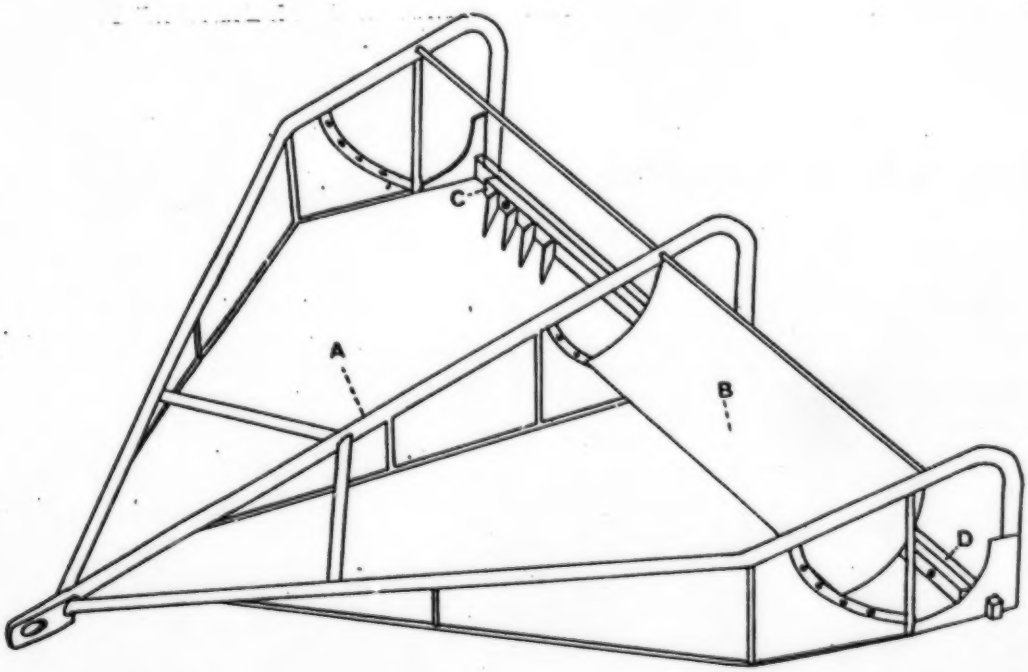

Fig. 6. Saint-Brieuc drag fitted with a depressor plate. The use of this type of drag is restricted to the northern coast of Brittany. Maximum weight: 200 kg. A: triangular towing hitch. B: depressor plate, left side. C: removable bar with teeth. D: bar mount.

than their predecessors. In addition, many scallop draggers use a derrick or hoisting gantry to lift the drag, and with the help of one of these power devices it is now feasible to empty the drag by the codend. Where this technique is used, the bar across the trailing end of the bag is replaced by a metal strip fitted with a bungee cord.

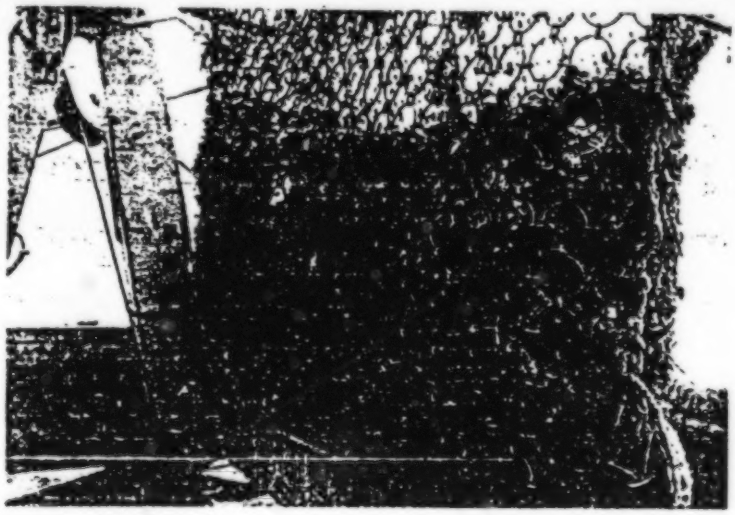

Fig. 7. A drag fitted with a depressor plate can harvest over 100 kg of scallops in a quarter of a hour.

Scallop drags of traditional design had always been plagued by poor ground-holding ability, and this was the major obstacle to efficient harvesting. In an effort to reduce the tendancy of drags to advance in a succession of short hops, scallop men placed weights on the metal rectangle that formed the mouth of the device. A crucial breakthrough was made early in the 1970s with the addition of a depressor plate at the rear of the triangular towing hitch (see Fig. 6). This innovation was first used by the draggers of Saint-Brieuc Bay. The plate, the angle of which is adjustable, causes the teeth of the drag to dig solidly into the sediment and makes it possible to work at higher speeds. Another advantage is that a shorter length of towing warp is required (three to

four times the water depth, as against five to six times the water depth with a conventional drag). Furthermore, a drag equipped with a depressor plate displays less of a tendency to turn over when it lands on the bottom, and thus there is less risk of its being towed upside down.

The author's own experiments indicate that when working loose ground, a drag fitted with a depressor plate was almost twice as efficient as a conventional drag (see Fig. 7).

Many scallop fishermen regard this type of drag as excessively destructive, however, and its use is permitted only on the northern coast of Brittany.

(b) The scallop fleet and harvesting methods

More than a thousand vessels engage regularly in scallop harvesting. These are invariably owner-outfitted and -operated.

It is difficult to define a typical scallop dragger in view of the wide range of variation between regions. However, power is an essential feature, as a boat's engine must develop ½ H.P. per kilogram of drag weight towed. Other standard characteristics are winches, hoisting gantries, derricks and double planking.

Crews range in size from one to seven men, depending on the size of the vessel and the number of drags towed.

In the case of the eastern Channel scallop fleet, which comprises 300 vessels, the average crew size is five, whereas in the case of the Brittany-Vendée fleet it is somewhere between two and three. In all, more than 3500 fishermen engage in this activity.

Harvesting methods fall into two categories, depending on the number of drags used.

An eastern Channel trawler-scalloper, for example, is between 15 and 20 metres long, and its two winch barrels must suffice to manoeuvre the eight to

ten drags that are towed simultaneously. This is achieved by dividing the towing warp into a number of sections of decreasing length which are linked together with Dieppe shackles. The drags are set two at a time, one to starboard and one to port.

When the towing warp has been reeled out as far as the first shackle, the shackle is detached from the winch and fastened to a ring located at the stern of the boat. The free end of the towing warp is then made fast to the second drag and reeled out as far as the second shackle. The first three or four pairs of drags are set in this fashion over the stern. The last pair of drags remain attached to the winch via the forward gallows. Each successive length of towing warp is about five metres shorter than the previous length, and consequently the drags are separated by that distance during the tow.

The harvesting methods used by most scallop draggers, however, fall into the second category. Only one or two drags are towed (see Fig. 7), and each drag is attached to a winch barrel. As a rule, the drags are set over the side; the towing warps run through gallows or, more simply, over rollers bolted to the rail.

Here, the boat and gear can be much more quickly manoeuvred, as only a few minutes are needed to hoist, empty and reset the drag, whereas between half an hour and an hour are required in the case of boats using the first type of harvesting method. It is also worth noting that the second type of method is highly flexible, as the length of towing warp used can be adjusted at will.

A further advantage is that a tow need last only fifteen minutes or so, rather than an hour or more, and this makes it feasible for the boat to work rough ground.

Lastly, this method is more efficient: horsepower for horsepower, it produces higher yields. However, as the boats involved are smaller (seven to twelve metres in length) and carry crews of only one to three men, their range is inevitably shorter and they are more at the mercy of weather conditions.

In most instances, scallop draggers stay out for a day at most, and as often as not they return after no more than a few hours. It is only the 30- to 60-tonne vessels of the eastern Channel fleet that undertake trips of up to 48 or even 72 hours. It is not practical for them to remain at sea for longer than this, as the scallops must be alive when they are landed.

4. Regulation of the scallop fishery

The scallop fishery is governed by a complex set of regulations.

A basic distinction must be drawn between beds located within France's territorial waters, which have been subjected to a classification procedure, and othe beds.

Along the country's entire littoral except the Mediterranean coast, scallop harvesting is prohibited from 16 May to 30 September. Landed scallops may not measure less than 10 cm at the widest point (see Fig. 1). Drags may not exceed 2 m in width or 200 kg in weight; the teeth must be set 10 cm apart and may not be more than 7 cm long. Drags fitted with depressor plates are lawful only in the western Channel sector.

In the case of scallop beds located within France's territorial waters, additional restrictions may be imposed by order of Marine Affairs or by decisions of the Trades Committee or Local Committees. The most striking instance is Saint-Brieuc Bay, where harvesting time has been progressively cut back to its present level of two to four hours per week between November and early April; during the 1976-1977 season, for example, only 74 hours of

harvesting were allowed. Furthermore, the scallop fleet cannot expand, as licences are issued to a maximum number of 466 boats powered by engines of less than 200 H.P. and towing not more than two drags.

The current trend among most of the industry is to restrict access to scallop beds to boats based at the nearest ports. The eastern Channel operators, for example, first succeeded in having drags fitted with depressor plates declared unlawful, and subsequently were able to have the opening of the harvesting season in the Baie de la Seine set back to November 1. This measure has been a major barrier to the mass arrival of the Breton scallop draggers, which had traditionally begun their season in October in the coastal waters of Normandy before heading for Saint-Brieuc Bay, where the season opened early in November.

Broadly speaking, the regulatory trend has been to provide additional protection for the beds and thereby encourage operators to take more of an interest in the management of the stocks they harvest.

In the case of the eastern Channel scallop beds, however, a serious problem may quite possibly be looming on the horizon. A large percentage of the total catch obtained from these beds is harvested outside France's territorial waters, where French regulations cannot be applied to scallop draggers from other countries of the European Community. As yet those countries possess only rudimentary scallop fleets, but the new Law of the Sea and the steady growth in consumer demand for scallops seem likely to encourage France's European partners to engage more actively in harvesting. The scallop populations of the eastern Channel could rapidly be depleted, unprotected as they are by any form of regulation.

Marketing

Scallops are packed whole by harvesters, either in crates, the concave valve down in order to maximize water retention, or in sacks weighing some 50 kg. The weighing is done by the buyer.

Exclusive sale contracts are still commonplace. Under a contract of this kind the boat owner undertakes, for the duration of a harvesting season, to sell only to a particular processor or dealer, while the buyer, for his part, agrees to take the whole of the season's catch at a price agreed between the parties.

Some boat owners who operate on a smaller scale, however, try to maximize their return by selling their catch directly to restaurants or retail outlets.

These methods, which are encouraged by the absence of harbour facilities, have constituted an obstacle to concerted action by scallop harvesters, especially in view of the fact that the dispersed locations of the ports have tended to foster rivalry between different maritime districts. This explains why attempts to organize scallop production have not been uniformly successful.

At present, the auction system is in increasingly common use at the main producing ports.

Beds	Weight (tonnes)	Price per kg (francs)	Market sector		
			Canned	Frozen	Fresh
Eastern Channel	9517	4.10	756	1552	7189
Saint-Brieuc Bay	8200	2.70	2750	--	5460
Brest Roads	200	5.00	25	--	175
Belle-Ile Shallows	160	5.80	--	--	160

Table 2. Production and sales of scallops harvested during the 1974-1975 season: tonnage, value and market sectors.
Source: Marine Affairs statistics.

Scallops had traditionally been regarded as a luxury product, and consequently they were slow to make their way into mass distribution channels. The substantial increase in output that has occurred in the course of the past ten years, however, has resulted in somewhat lower prices and steady growth in consumption.

Seventy-five per cent of the catch is sold fresh and 20% is sold to canneries; the remainder is frozen. There are substantial regional disparities in the proportions accounted for by the various market sectors, and prices vary considerably between regions as well (see Table 2).

Prices are determined essentially by two factors. The first of these is product quality, which in turn depends on yields of edible parts and the presence or absence of the coral (the swollen genital gland). The other factor is the interplay of supply and demand, which goes a long way toward explaining even quite sizable price movements.

In Saint-Brieuc Bay, these two conditions seldom operate to the advantage of the boat owners: the gonad is flat for the first four months of the harvesting season, and the scallops are usually very young, so that their yield of adductor muscle meat is not very great. As a result, much of the catch is sold for processing.

The canning and freezing industries undoubtedly serve to make scallops available to consumers for a longer period. However, France's domestic production is not sufficient to supply these industries with all the raw material they need, and consequently imports of scallops have risen steadily: in recent years, in fact, those imports have amounted to over 10 000 tonnes annually, a quantity equal to half the total domestic catch.

The edible parts of a scallop comprise the adductor muscle, the gonad or coral, and sometimes the outer edge of the mantle, or beard. From

six to ten kilograms of scallops, depending on the age and place of origin of the specimens concerned, are required to produce one kilogram of muscle meat. The coral, which is highly prized by French consumers, accounts for a maximum of 10% of the live weight, depending on the specimen's state of maturity. The beard, for its part, is used only by the occasional exceptionally thrifty housewife. In all, the yield of edible parts amounts to between 10% and 25% of the total live weight.

Both muscle meat and coral are rich in protein: Mason (1959) and Comely (1974) found that protein accounted for between 65% and 80% of total dry weight. The carbohydrate content of the muscle meat is high at between 15% and 20% of the total dry weight, whereas carbohydrates account for no more than 1% to 2% of dry weight in the case of the coral. As regards lipid content, the reverse is the case: lipids account for 1% to 3% of total dry weight in the case of muscle tissue, but for 5% to 12% in the case of the gonad. Water content ranges between 75% and 80%.

The outlook

France is exceptionally fortunate in possessing a wealth of scallop resources, but this fact should not blind us to the problems arising from the rapid growth of harvesting activity and rising consumption.

For the past four years production has remained stable at roughly 20 000 tonnes a year, while domestic demand is already running at 30 000 tonnes yearly and is likely to increase to 50 000 tonnes yearly within the next ten years. This deficit in supply may well be aggravated by a harsher competititve situation as scallop draggers from France's European partners move in to work the beds that lie outside France's territorial waters.

Furthermore, recruitment rates among scallops are subject to large fluctuations, and this makes it more difficult for a population to maintain itself. Many a scallop fishery has experienced successive periods of prosperity and decline.

There are a number of possible long-term or moderately long-term solutions to the problem of inadequate production. While it is unlikely that new beds of Pecten maximus will be discovered, this is not the case for related species such as Chlamys varia or C. opercularis. While these scallop species are eminently edible, they do not keep well, and this has been an obstacle to successful marketing. However, the adoption of new technologies such as the automated shucking equipment that has been developed in North America and Great Britain would make it possible to use them as feedstock for the canning and freezing industries. Advertising campaigns would generate demand for these products, which could be used quite satisfactorily in place of Pecten scallops in various recipes.

While it is true that harvesting activity has reached a plateau, as is evident from the stable size of the scallop fleet and the stagnation in quantities landed, the application of rational resource management techniques should afford a means of increasing catches. The author's own research on population dynamics in the scallop beds of Saint-Brieuc Bay, for example, indicates that increasing the minimum legal commercial size to 11.5 cm would cause stocks to double within four to five years; this would result in a 30% increase in the catch in terms of gross weight, and a 50% increase in terms of edible weight. Another useful measure would be to shift the harvesting season back one month, so that it extended from December to early May instead of from November to early April. The coral would then be more fully formed, and this would increase the value of the catch.

A final possibility is restocking. To be sure, it is fairly difficult to move adult scallops from one bed to another, but reseeding with spat, as the Japanese have successfully done, is a promising alternative. The technique involves gathering scallop larvae at the age when they become adherent by placing collectors in the water at exceptionally favourable locations. The larvae collected in this way are subjected to several months of precultivation, and then reimmersed in depleted beds or in their own beds of origin. This procedure substantially enhances the survival rate of the larvae. Trials in France with Pecten larvae have not yet yielded results comparable to those achieved in Japan; however, the results obtained with Chlamys larvae have been sufficiently promising to warrant optimism about future prospects.

Conclusion

Within the space of only a few years, scallops have come to account for a predominant share of the overall production of the French fishing industry.

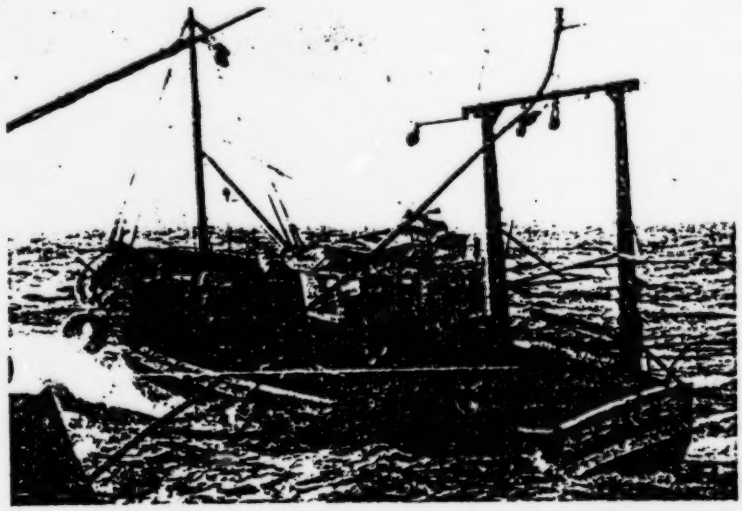

Fig. 8. A scallop dragger out of Erquy, in Saint-Brieuc Bay. The two drags are set over lateral rollers and the scallops are put into sacks.

Scallops are a resource that is essential to sustain a fleet of over 1000 boats worked by 3500 seamen. To date it is a resource that has been of benefit essentially to France's English Channel littoral, from Brittany to the Straits of Dover.

Despite strict regulation and the stabilization of the harvesting effort, the future of the scallop fishery is most uncertain. The fact that only a single species is harvested means that the fishery is vulnerable to substantial fluctuations in stocks resulting from erratic recruitment rates.

Furthermore, France's domestic consumption of scallops has increased very rapidly, while already the country imports such large quantities as to give cause for concern.

The dangers inherent in harvesting only a single species of scallop and the shortfall in France's supplies can be overcome by three main types of action: promotion and development of the harvesting of substitute species of Pectinidae, the rational management of stocks on the basis of population dynamics studies, and the collection of spat for use in restocking depleted scallop beds.

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